

2021 Chehalis ASRP Western Ridged Mussel Surveys

Progress Report

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This report provides an interim update on surveys for the Western Ridged Mussel (*Gonidea angulata*) and other mussel species in the Chehalis River Basin in 2020. Recent large-scale mortality events have been documented across the range for many of these mussel species, including areas in the Chehalis River Basin (Blevins 2020). The Western Ridged Mussel is currently proposed for federal listing (Blevins 2020), causing additional concern. Our study's objective is to document freshwater mussel occurrence and distribution throughout the Chehalis River Basin, where our knowledge is minimal. We seek to understand how freshwater mussels may be impacted by a potential dam or influenced by restoration efforts in the basin.



We focus on the Aquatic Species Restoration Plan (ASRP) target species: the Western Ridged Mussel. This mussel species is an ASRP indicator species, in part, because of its symbiotic association with native fish and its ability to improve to water quality. We also consider Floater Mussel (*Anodonta spp.*), Western Pearlshell Mussel (*Margaritifera falcata*), and the nonnative Asian Clam (*Corbicula fluminea*) as target species. Although there can be habitat similarities, each species has its own preferred habitat niche (Nedean et al. 2009; Blevins et al. 2017). Floater Mussels are softer shelled and more fragile than Western Pearlshell Mussels and, as such, tend to prefer slow water with sandy/muddy substrate for burrowing, whereas Western Pearlshell Mussels can occur in substrate of varied types and sizes (Nedean et al. 2009).

Our goals are to:

- Establish a baseline of freshwater mussel distribution throughout areas where mussels have not previously been surveyed for and emphasize documentation of any potential die offs.
- Report relevant localities in Early Action Reaches (EAR's) and other restoration sites to consulting firms to help guide restoration efforts.
- Inform the impacts of flood control actions, current and future restoration actions, and the impacts of climate change by providing a baseline to which future occupancy and distribution of target freshwater mussel species can be compared through time. Target audiences for this work include the:

- Chehalis River Basin Flood Damage Reduction Project Environmental Impact Statement
- Chehalis Basin Strategy Aquatic Species Restoration Plan
- Chehalis Basin Board
- Restoration practitioners
- Public at large
- Coordinate on survey locations and protocols with project partners including Xerces Society, USFWS, and The Confederated Tribes of the Chehalis.

TARGET STUDY AREA

We focused our surveys on areas that were identified with project partners to be data deficient with respect to freshwater mussels and areas that are likely to be impacted by restoration activities or flood control actions. These included:

- Upstream and downstream of the proposed flood retention facility near Pe Ell, WA
- Black River
- Lincoln, Bunker, Independence, and Garrard Creeks
- Scatter Creek
- Other junctions of major tributaries with the Chehalis mainstem for Western Ridged Mussels as opportunistically encountered.
- When needed, EAR priority sub-basins (South Fork Chehalis, Satsop, and Wynoochee).

The predominant land uses in the target areas are mixed by location. Forestry typically dominates higher elevation locations near Pe Ell and in the upper reaches of most streams. Lower elevation or floodplain reaches are primarily a mixture of agriculture and rural human/residential development. Areas of the Black River in the floodplain retain natural vegetation, wetlands, and riparian areas with deciduous trees.

METHODS

Although our initial target was to initiate fieldwork in July our field season was abbreviated from August 26 to October 28 due to challenges associated with the COVID-19 pandemic in 2020. We focused our surveys on the upper mainstem Chehalis River near Pe Ell (upstream and downstream of the proposed dam), the Black River, and Lincoln Creek (**Figure 1**). We also surveyed three sites with previous environmental DNA (eDNA) confirmation of mussels on Lincoln, Sherman, and Waddell Creeks (results from Marie Winkowski for Western Pearlshell Mussels) to “ground-truth” eDNA results. Our surveys encompassed medium to large streams/rivers (Strahler order 4th-7th) with a very small reach of 3rd order stream in the upper Black River.

Water conditions, especially visibility and depth, can greatly impact surveys, emphasizing the need to pay careful attention in recording variation within these parameters. In good conditions, mussels were detected by visual survey methods. When water visibility was poor, surveys were conducted by manually reaching into the sediment and feeling for mussels without the aid of vision (tactile surveys). Areas with deep water could not be surveyed by feel and vegetation occasionally

also prevented access to stream banks. The majority of Lincoln Creek and large sections of Black River were surveyed by feel rather than sight. We surveyed approximately 95 total river miles (RM; 153 river km) during the 2-month survey window (**Figure 1, Table 1**).

Surveys were conducted by teams of two to five crew members snorkeling and wading reaches and continuously searching for mussels. We sampled river and streams reaches in an upstream direction to allow for disturbed sediments to flow out of the sampling areas in order to maintain water clarity. When necessary, due to flow or environmental conditions, we sampled in a downstream direction. In smaller streams, we spent significant time identifying adjacent landowners and requesting permission to survey. In some reaches where landowner permission was denied, we did not sample, resulting in occasional gaps in surveyed areas. In other areas, obstructions in the river (such as dense vegetation, woody debris, or other safety hazards) prevented surveys.

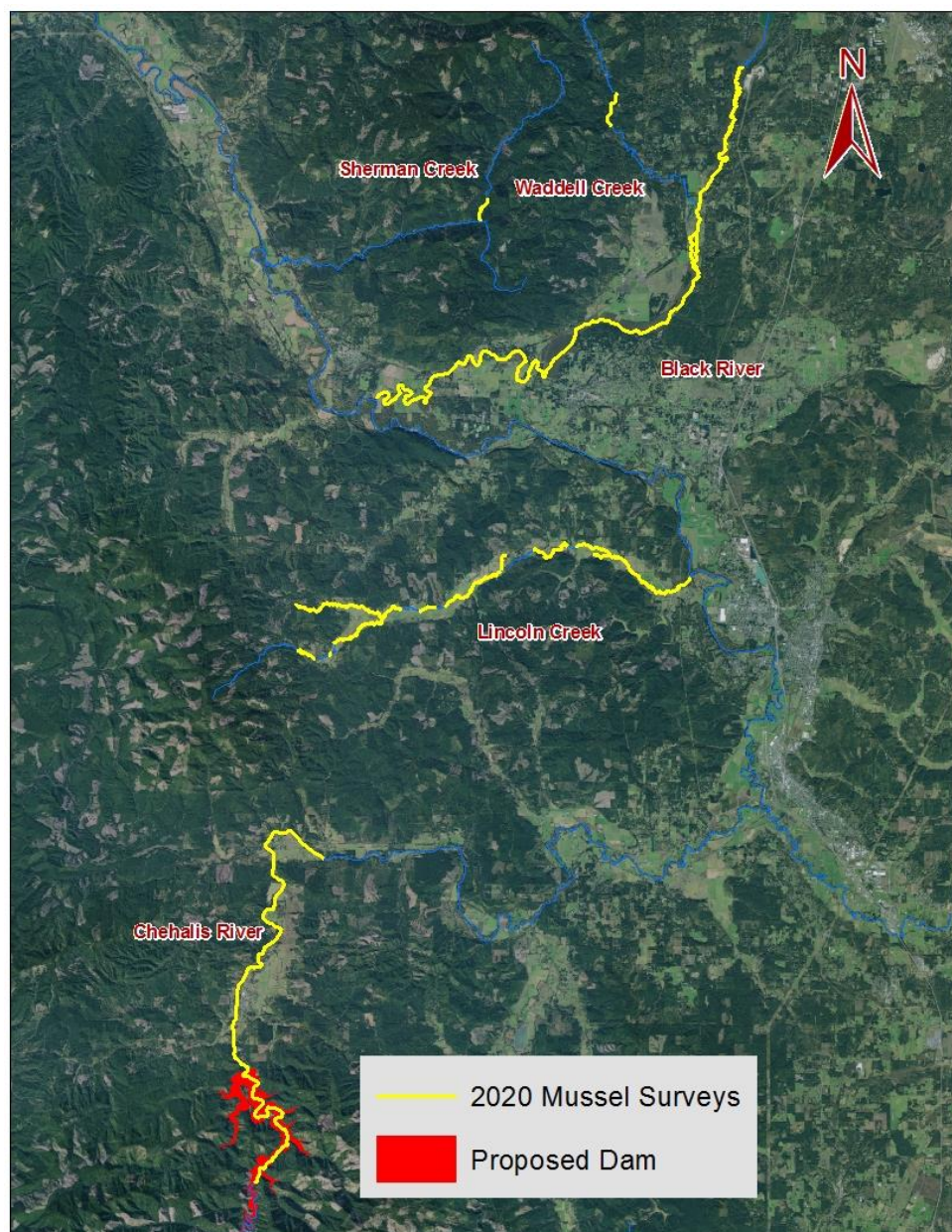


Figure 1. Locations and distribution of freshwater mussel surveys conducted in the Chehalis River Basin in 2020.

At the start and end of each survey, we recorded: date, surveyors, start/end time, river section ingress/egress description (GPS, roads, address etc.), air temperature (°C), water temperature (°C), water clarity (Clear, Stained [algae/tannic/rusty], Silty, or Turbid), water visibility with changes described throughout reach, survey method (Snorkel, Wade, Wade/Aquascope, Kayak), total survey time excluding rest breaks, and general comments.

When freshwater mussels were observed, we recorded: date, river section, ingress/egress description, site ID, GPS for both downstream and upstream end of mussel bed, bank side (looking downstream - left, right, middle) and species identification (Western Pearlshell, Western Ridged, or Floater Mussels). We recorded categorical species counts (Rare <20, Common 20-100, Abundant >100) for live, recently dead (with flesh still attached), and empty (dead) shells. In addition, for “Common” or “Abundant” beds (beds 20+ mussels regardless of species), we also recorded the relative impression of bed size compared to other beds, presence of variable size or age classes of mussels, macrohabitat¹, embeddedness in substrate², density (Clumped, Scattered, or Continuous), site photograph, photographs of observed species, and habitat photographs. We also recorded incidental observations of aquatic species and other species of interest that we observed.

Data were recorded electronically by tablet in form-based software (iForm) in the field. We checked entered data for accuracy and downloaded data into an Excel spreadsheet which will be followed by QA/QC review to ensure quality and accuracy. Data is stored on WDFW servers that are backed up nightly.

Table 1: Total river miles surveyed in 2020, stratified by stream and type of survey.

Stream	River Miles (Rkm) Surveyed	Type of Survey
Black River	38.7 (62.3)	Exploratory Survey
Chehalis River	24.5 (39.4)	Exploratory Survey
Mainstem Lincoln Creek	17.8 (28.6)	Exploratory Survey
North Fork Lincoln Creek	5.4 (8.7)	Exploratory Survey/eDNA Verification
South Fork Lincoln Creek	5.6 (9.0)	Exploratory Survey
Sherman Creek	1.2 (1.9)	eDNA Verification
Waddell Creek	1.8 (2.9)	eDNA Verification

KEY RESULTS

We did not find Western Ridged Mussel (*Gonidea angulata*) in any areas searched in 2020, but we did find Western Pearlshell and Floater Mussels. Across all survey areas, we documented 119 freshwater mussel beds, 18 beds of which had two species present (Western Pearlshell: n=76, Floater: n=43). We identified Western Pearlshell Mussels in all systems surveyed and found Floater Mussels in the Black River and Lincoln Creek. The Chehalis River surveys did not identify any mussel beds in the vicinity of the proposed dam footprint and the

¹ Macrohabitat: Pool, Run, Riffle, Rapids, Side-Channel, Pond, Lake, Ditch, Canal, Slough as well as “in the substrate” or “along/under bank”

² Embeddedness: (burrowed deeply to the apertures, somewhat less buried -1/3 to 2/3 of mussels above the substrate, unburied or >2/3 visible above the substrate)

nearest bed was 7 miles downstream of River Mile 101, close to the town of Doty (**Figure 2**). We documented only 10 mussel beds in the Chehalis River and all were Western Pearlshell Mussels (**Table 2, Figure 2**). Despite the rarity of mussel beds in the Chehalis River, half of the Western Pearlshell beds here were robust and scored as having “Abundant” mussels (**Figure 2**).

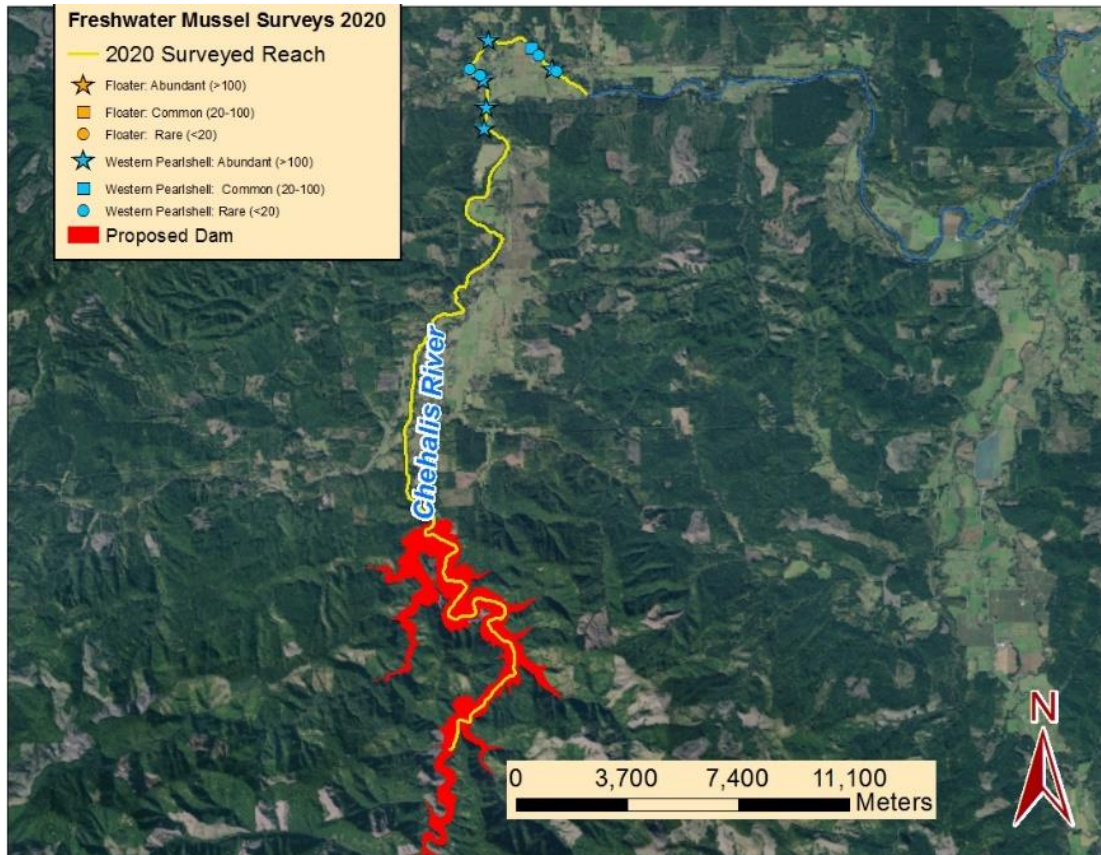


Figure 2. Mainstem Chehalis mussel location and abundance and the proposed dam footprint. Only Western Pearlshell Mussels were detected downstream of the proposed dam in the main stem Chehalis.

Table 2: Total number of identified mussel beds stratified by stream and River Mile (RM)

Stream	# of Mussel Beds Present	% of Beds Identified	Beds/RM (Beds/RKm)
Black River	32	26.9	0.83 (0.51)
Chehalis River	10	8.4	0.41 (0.25)
Lincoln Creek	74	62.2	2.57 (1.60)
Sherman Creek	1	0.8	0.83 (0.53)
Waddell Creek	2	1.7	1.11 (0.69)

Lincoln Creek had both the highest density of mussel beds and was the stream where we detected most mussel beds across surveys (**Table 2**). Western Pearlshell and Floater Mussels were largely spatially segregated within Lincoln Creek, with Western Pearlshell beds largely upstream and Floaters downstream (**Figure 3**). Why these species are spatially separated is unclear and further analysis of macrohabitat data and site characteristics may illuminate why we observe such

stark spatial segregation in Lincoln Creek mussel occupancy. Notably, Lincoln Creek not only had a high density of mussel beds in general, but also a relatively large number of beds where Western Pearlshell Mussels were scored as “Abundant” (**Figure 3**). Although Floater Mussel beds were relatively common in Lincoln Creek, few of these beds were sizeable and most were scored as a “Rare” density (**Figure 3**).

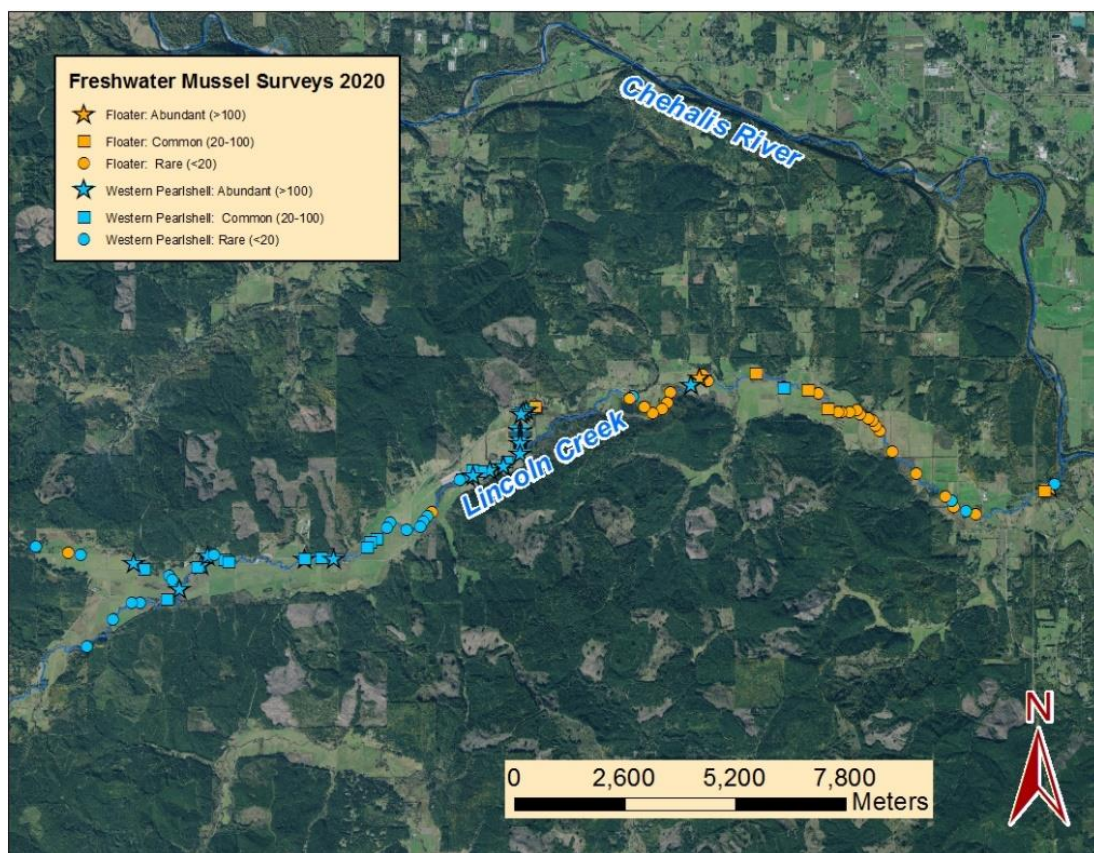


Figure 3. Lincoln Creek mussel location and abundance.

Despite surveying more miles within the Black River, we detected fewer beds and a lower density of mussels here in comparison to Lincoln Creek (**Table 2**). Like Lincoln Creek, mussel species appear to be spatially segregated in the Black River, however with a reversed pattern. Specifically, Floater Mussel beds tend to be concentrated upstream and Western Pearlshell Mussel beds are largely downstream in the Black River (**Figure 4**). As with Lincoln Creek, further analysis of macrohabitat data and site characteristics may illuminate why we observe stark spatial segregation in species occupancy in the Black River. The Black River had a lower prevalence of “Abundant” Western Pearlshell beds and was dominated by beds scored as “Rare”.

Beyond stream-specific patterns, mussel counts in most beds were “Rare (<20)” (63.9% of all beds, **Table 3**). “Common (20-100)” and “Abundant (>100)” species counts represented 16.0% and 20.2% of mussel beds, respectively (**Table 3**). We also documented abundances of dead mussels in beds, including fresh dead (flesh on) or empty shells at each bed. Six Floater and 14 Western Pearlshell Mussel beds (20 beds total) had dead mussels. The frequency of beds with dead

mussels was similar between the two species and proportional to each species' abundance ($\chi^2 = 0.14$, $p = 0.71$), suggesting the frequency of dead mussels across beds was not biased towards one species. All six Floater Mussel beds with dead mussels were scored as “Common”. Of the 14 Western Pearlshell Mussel beds with dead mussels, six were scored as “Common” and eight as “Abundant”. The actual extent and cause of these mortalities is unknown but is something we aim to document for potential site revisits in the future.

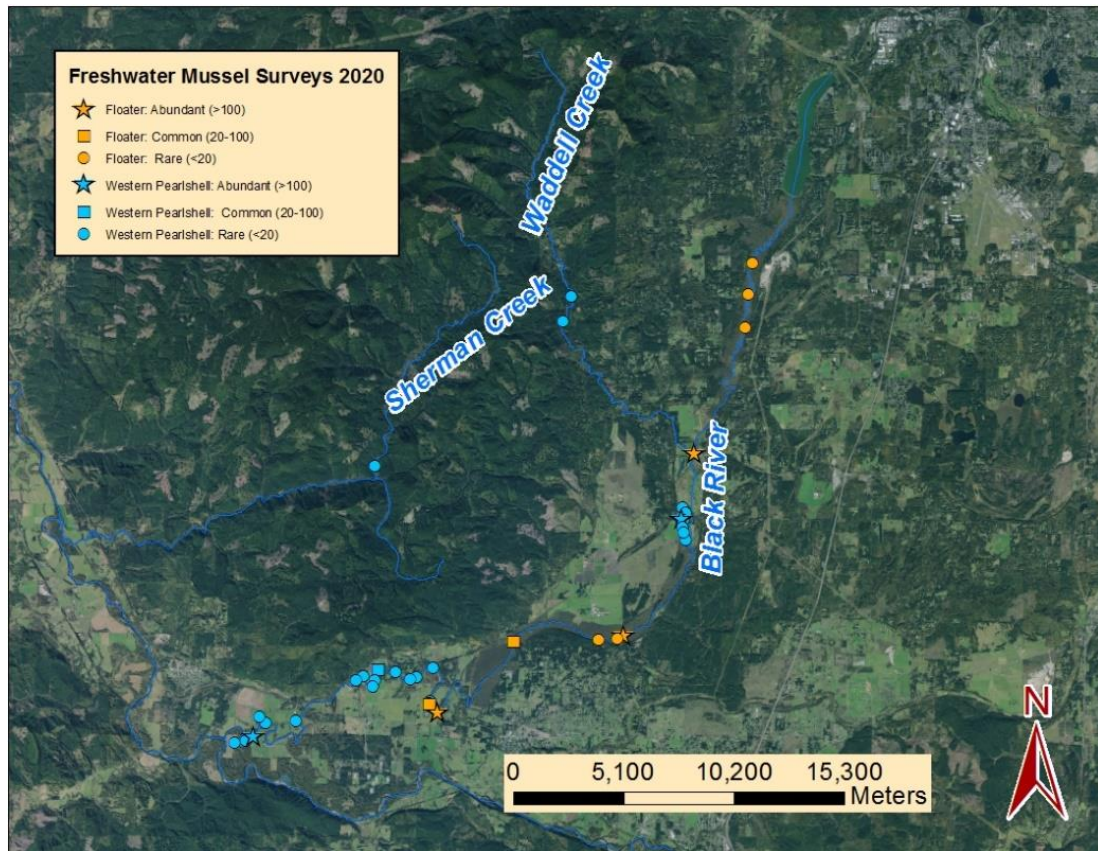


Figure 4. Black River, Waddell Creek, and Sherman Creek mussel locations and abundance.

Table 3: Species breakdown of bed counts and overall abundance categories.

Species	Bed Count	Rare (<20)	Common (20-100)	Abundant (>100)
AN = Anodonta spp. (Floater Mussels)	43	31	7	5
MF = M. falcata (Western Pearlshell Mussels)	76	45	12	19
Total # of Beds	119	76	19	24
Abundance Category %		63.9%	16.0%	20.2%

NOTABLE BED LENGTHS

In addition to point locations for mussel beds, we also recorded the spatial extent of each bed using upstream and downstream GPS coordinates. This allowed us to visually map the length of entire mussel beds. The longest Western Pearlshell Mussel beds encountered during the 2020 surveys were in Lincoln Creek and were 1,070 m (**Figure 5A**) and 900 m (**Figure 5B**) long. The next longest Western Pearlshell Mussel beds were in the mainstem Chehalis River upstream of the Doty bridge and were 860 m and 830 m long (**Figure 6**). The longest beds of Floater Mussels were found on the Black River (3,440m & 5,100m) (**Figure 7**).

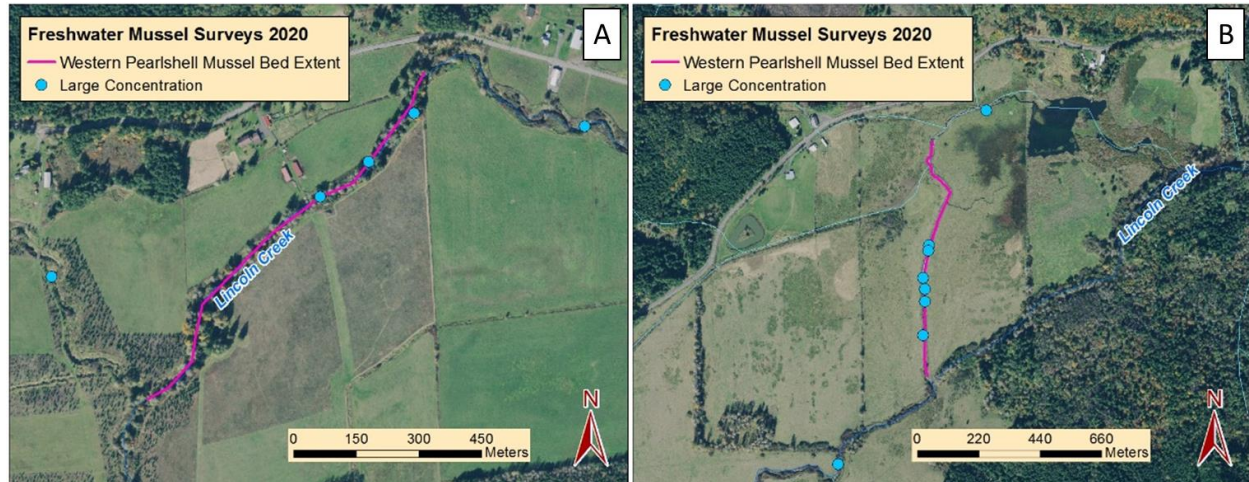


Figure 5. Extent of large, continuous Western Pearlshell beds in Lincoln Creek (A) and an unnamed tributary of Lincoln Creek (B)

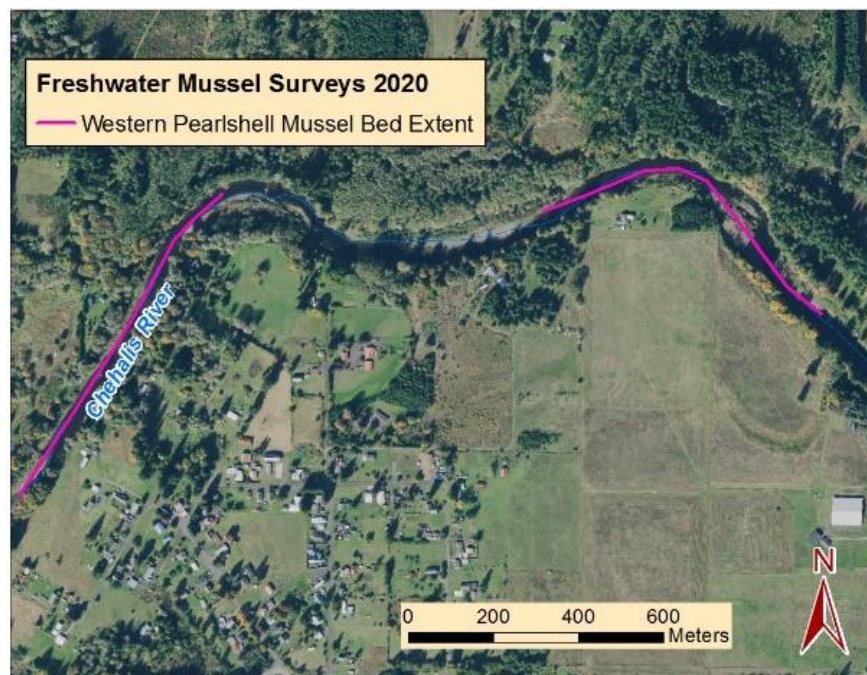


Figure 6. Extent of two large Western Pearlshell Mussel beds in the Upper Chehalis River near Doty.

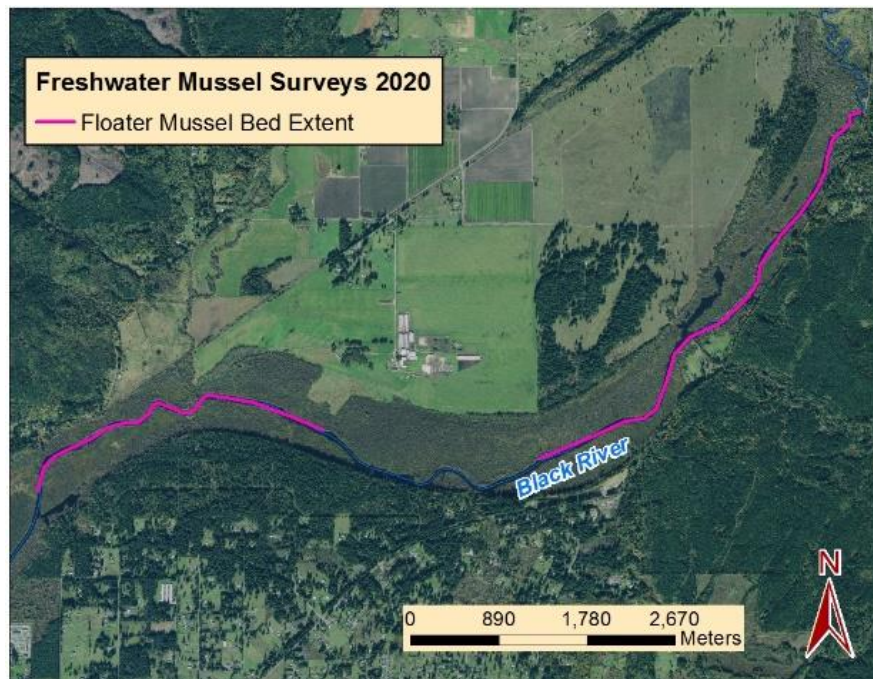


Figure 7. Extent of large beds of Floaters in the Black River.

eDNA “GROUND-TRUTH” RESULTS

Waddell Creek: We surveyed one section of Waddell Creek in response to a positive eDNA result. We surveyed approximately two river miles, starting west of the Waddell Creek Campground and ending upstream south of Sherman Road SW. We detected Western Pearlshell Mussels in a low density (n=4 Mussels) approximately 1,075 & 2,555 meters upstream of the eDNA detection and thus confirming the eDNA detection (**Figure 8**).

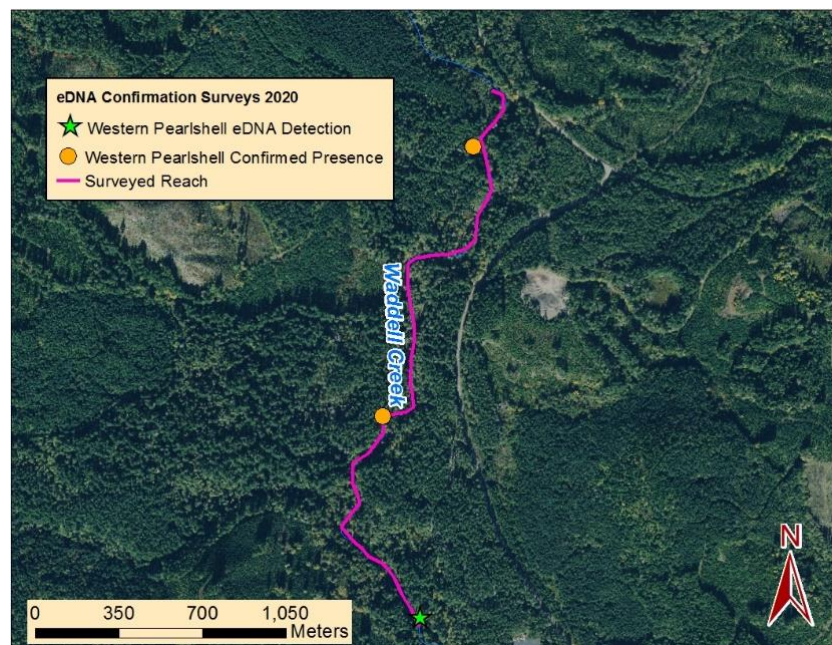


Figure 8. Waddell Creek eDNA surveys illustrating our surveys in response to a Western Pearlshell Mussel eDNA detection and confirming the eDNA detection with our detections upstream.

Sherman Creek: We surveyed approximately one river mile starting at the confluence with Cedar creek and surveying upstream in Sherman Creek in response to an eDNA detection of Western Pearlshell Mussels. Our surveys found Western Pearlshell Mussels in low density (n=2 mussels) less than five meters upstream of the eDNA detection, confirming the eDNA detection (**Figure 9**).

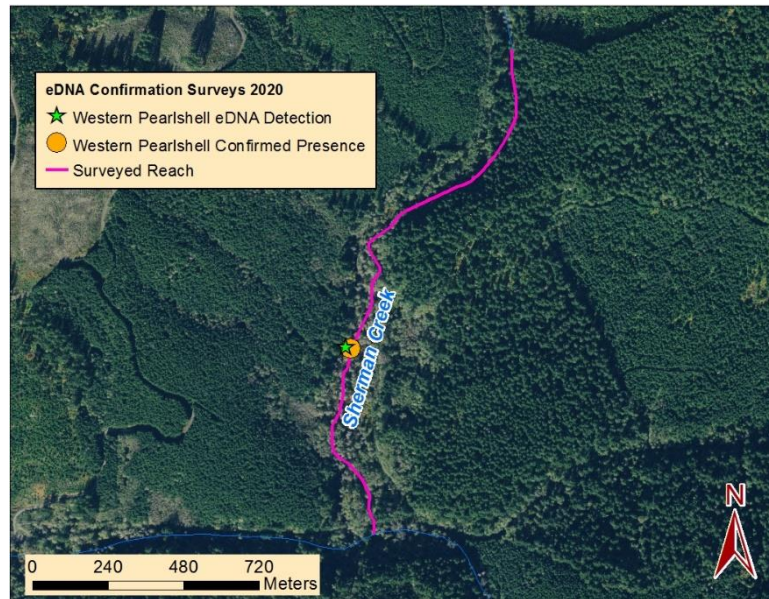


Figure 9. Sherman Creek eDNA surveys illustrating our surveys in response to a Western Pearlshell Mussel eDNA detection and confirming the eDNA detection with our detections upstream.

North Fork Lincoln: We surveyed 5.4 river miles of North Fork Lincoln upstream from its confluence as part of our exploratory surveys. This survey region includes a location where eDNA surveys had detected Western Pearlshell Mussels previously. Approximately 725 meters upstream of the eDNA detection location, we documented a single Western Pearlshell Mussel, confirming the eDNA detection (**Figure 10**).

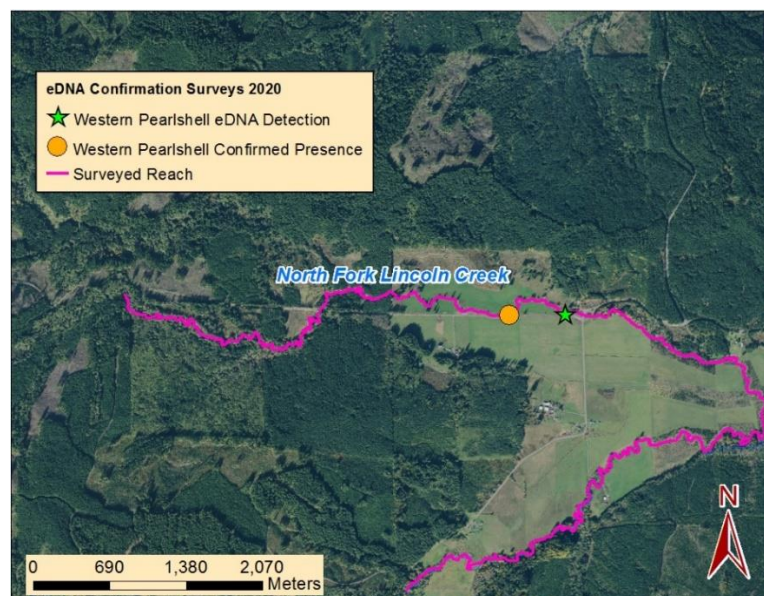


Figure 10. Lincoln Creek eDNA surveys illustrating our surveys in response to a Western Pearlshell Mussel eDNA detection and confirming the eDNA detection with our detection upstream.

ONGOING RESEARCH

In 2021, we are surveying Bunker, Independence, Garrard, and Scatter Creeks. In addition, we will be focusing efforts on the Chehalis River junctions of larger tributaries like the Newaukum and Satsop Rivers, as these are expected to offer more suitable habitat for Western Ridged Mussels (E. Blevins, personal communication). We are also revisiting historic Western Ridged Mussel sites in the mainstem and surveying remaining eDNA mussel detection from Marie Winkowski's 2019-2020 work; our work to date suggests our surveys will continue validating the efficacy of eDNA and may provide insights into the tradeoffs of eDNA versus traditional surveys for mussels. In 2022 we will complete surveys under the ASRP Status and Trends funding and by the end of the 21-23 biennium will finalize our status report on mussels in the Chehalis Basin.

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